

Adolescent Substance Abuse and the Adolescent Brain: Treatment Implications

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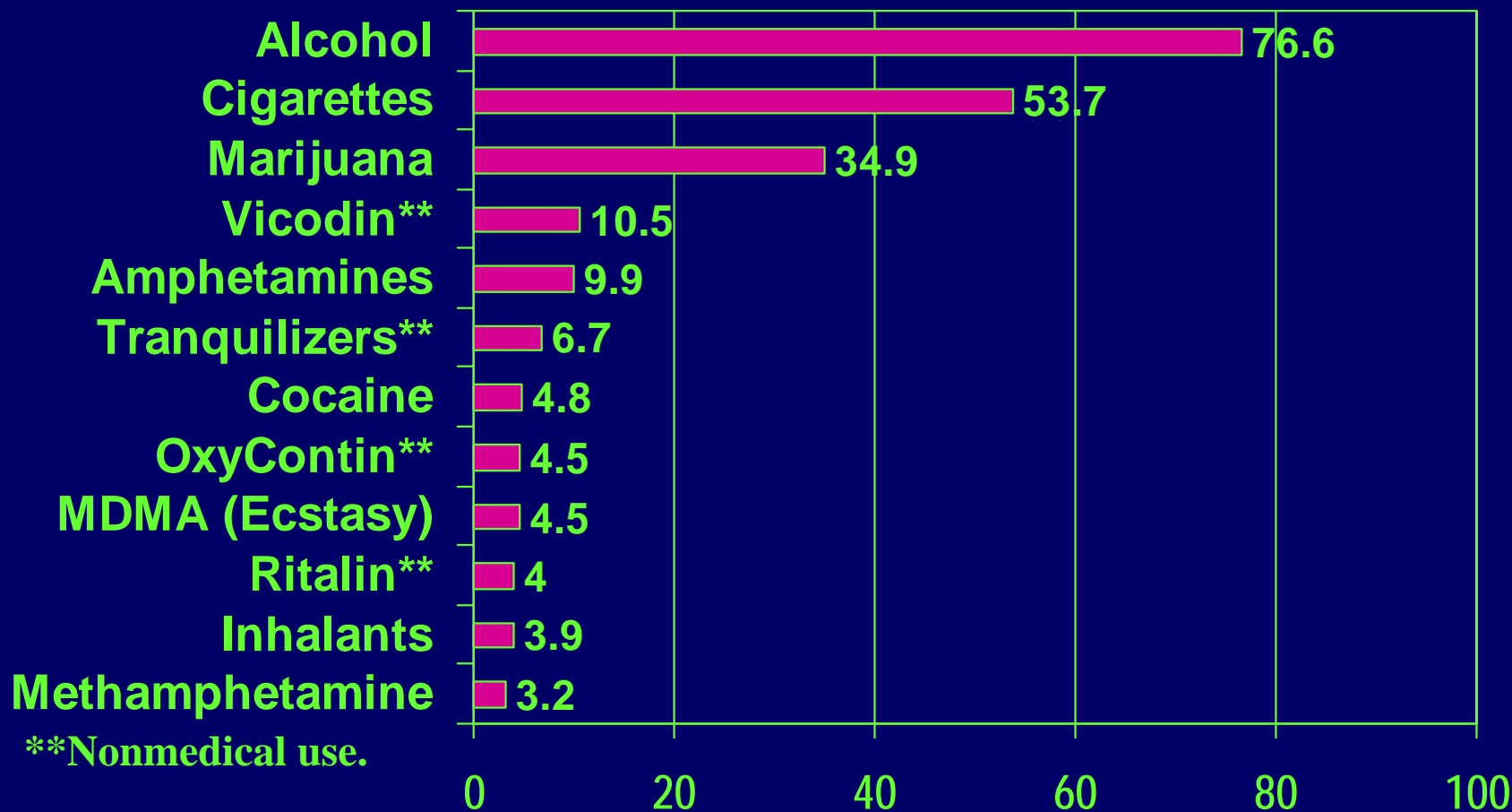
**Addictions Consultant, WI Bureau Mental Health & Sub
Abuse Services**

Goals

Become familiar with

- ◆ **Patterns of alcohol and drug use among youth**
- ◆ **Natural history of addiction**
- ◆ **Neurobiology of adolescent brain and its relationship to addiction**
- ◆ **Genetics of addiction**
- ◆ **Treatment strategies that are “win-win”**

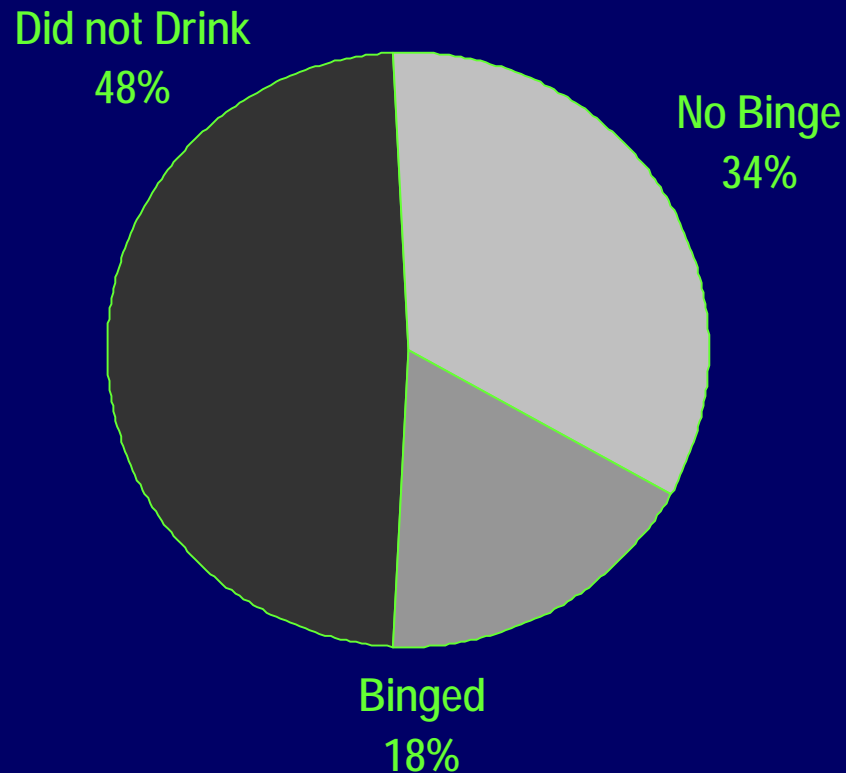
Ranking of Illicit Drugs Among 12th Graders, Past Year Use, 2003



Alcohol: Wisconsin Adolescents

- ◆ ***52% reported having had at least one alcoholic beverage in the past 30 days.***
- ◆ ***66% who had drunk alcohol in the past month drank five or more drinks at one time***
- ◆ ***Males were more frequent alcohol drinkers and were more likely to report binge drinking than females***
- ◆ ***There was a slight increase from 1993 to 1999 among students who said that they had never drunk alcohol from 20% to 23%***

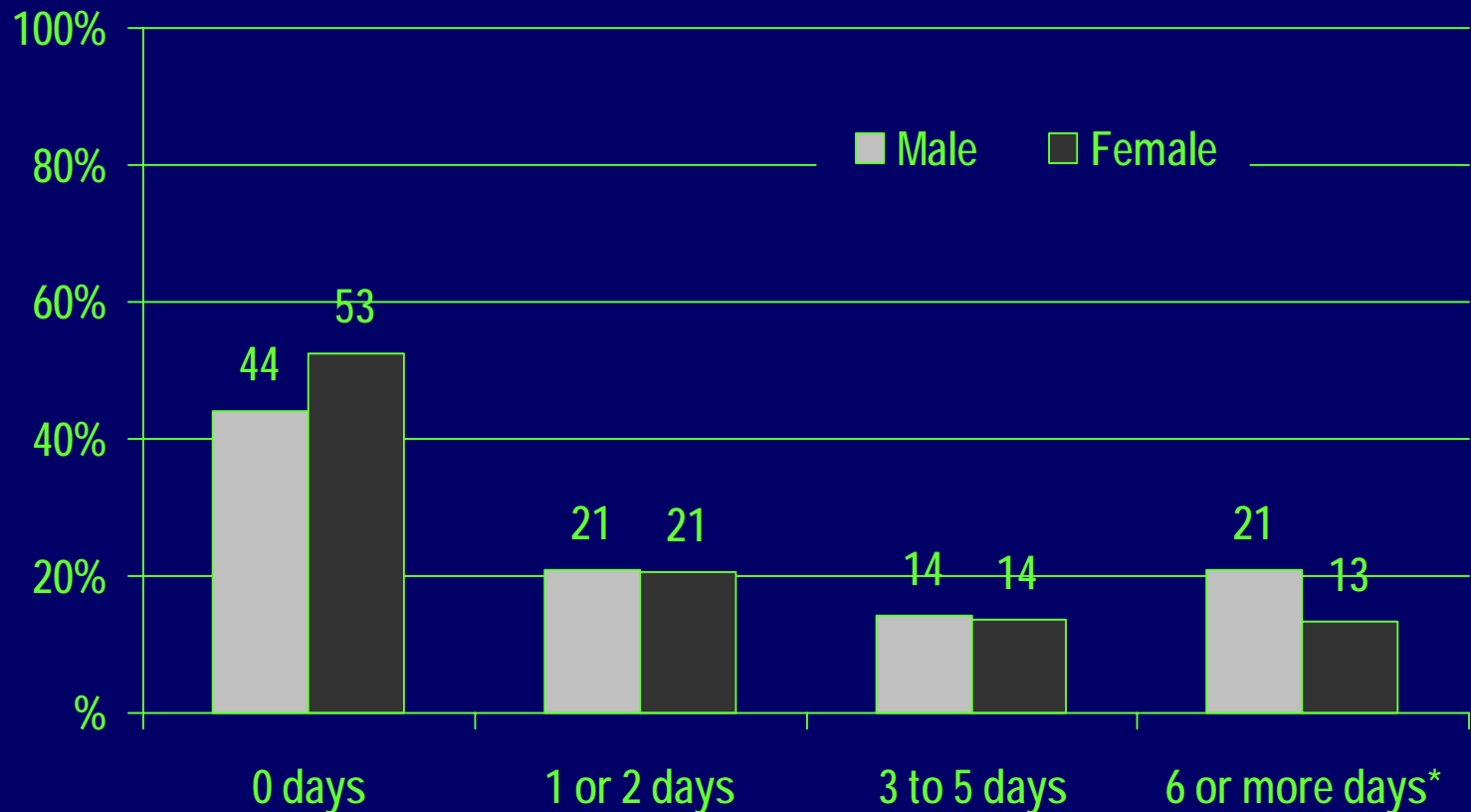
WI Adolescent Drinking Behavior Past Month



Binge = 5+ drinks/occasion

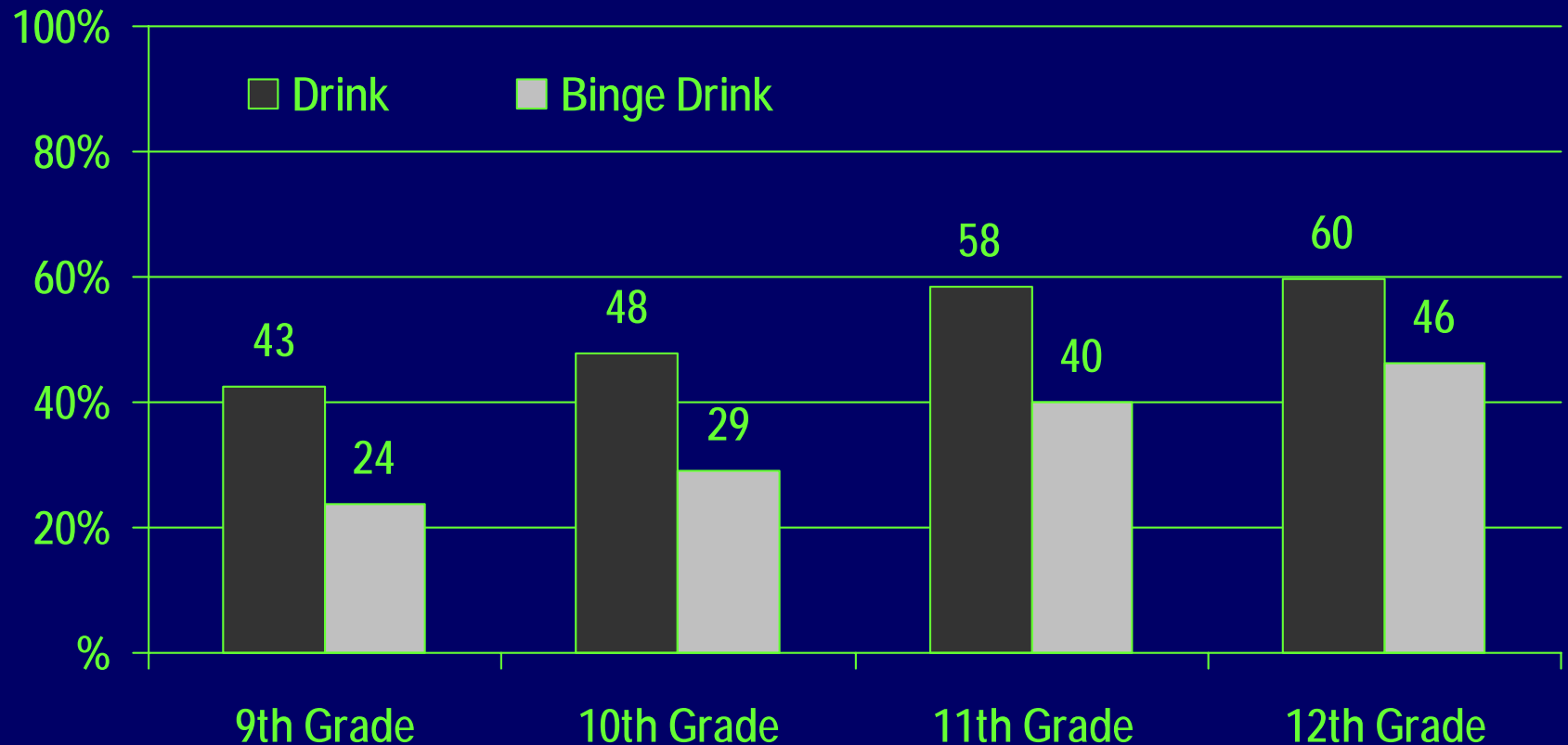
WI BSAS and DPI, 2004

Frequency of Drinking by Gender Among WI Adolescents, Past Month



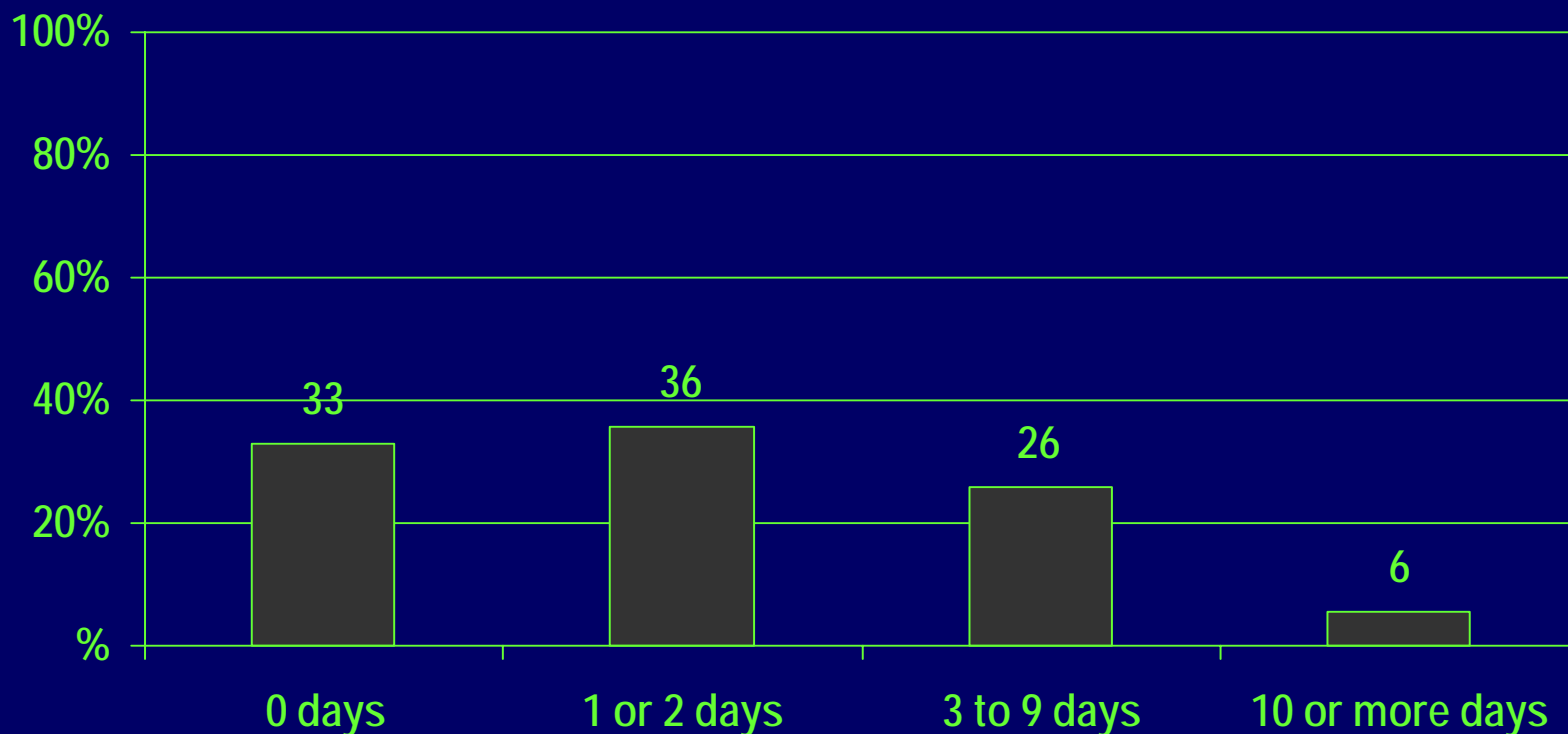
** Differences are statistically significant (with 95% confidence)*

Drinking and Binge Drinking by Grade Level Among WI Adolescents, Past Month



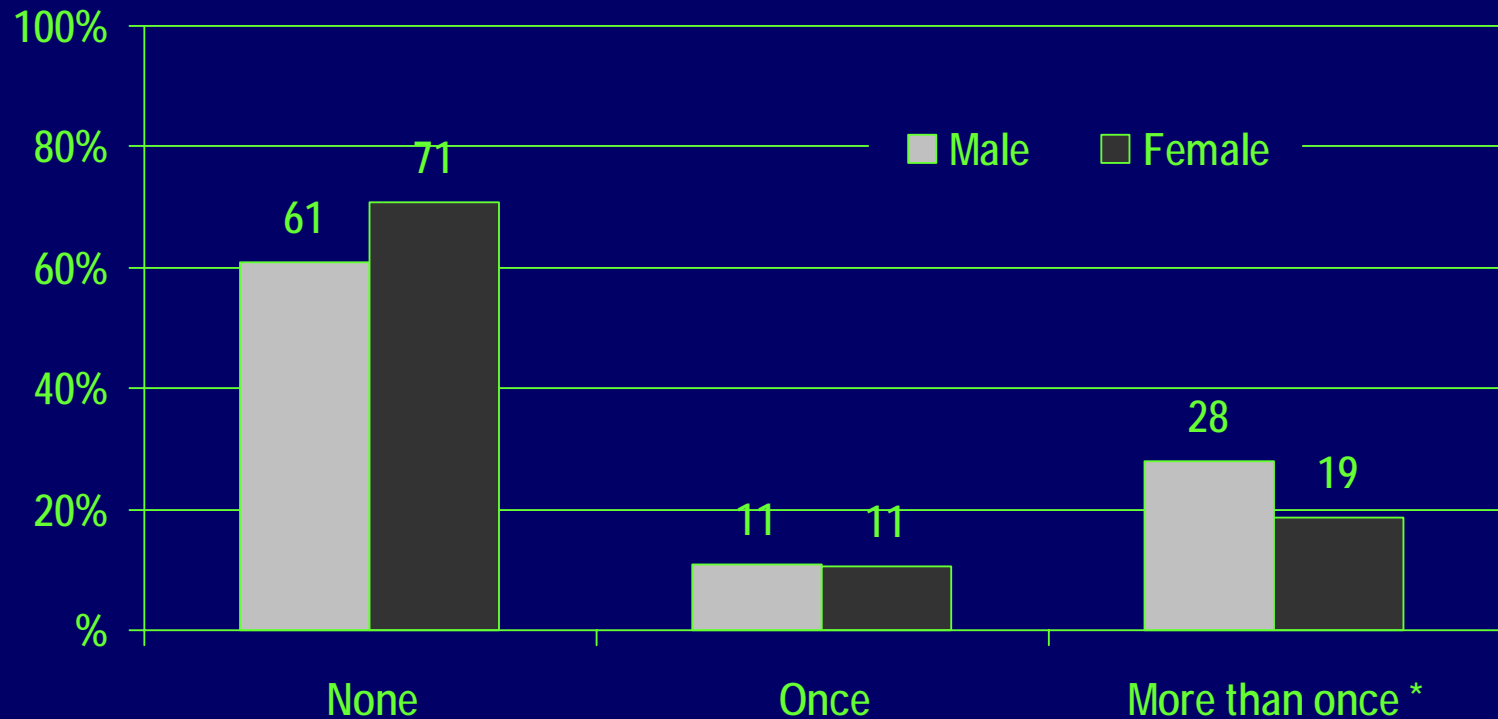
WI BSAS and DPI, 2000

Binge Drinking [5+ / occasion] Frequency Among Current WI Adolescent Drinkers Past Month



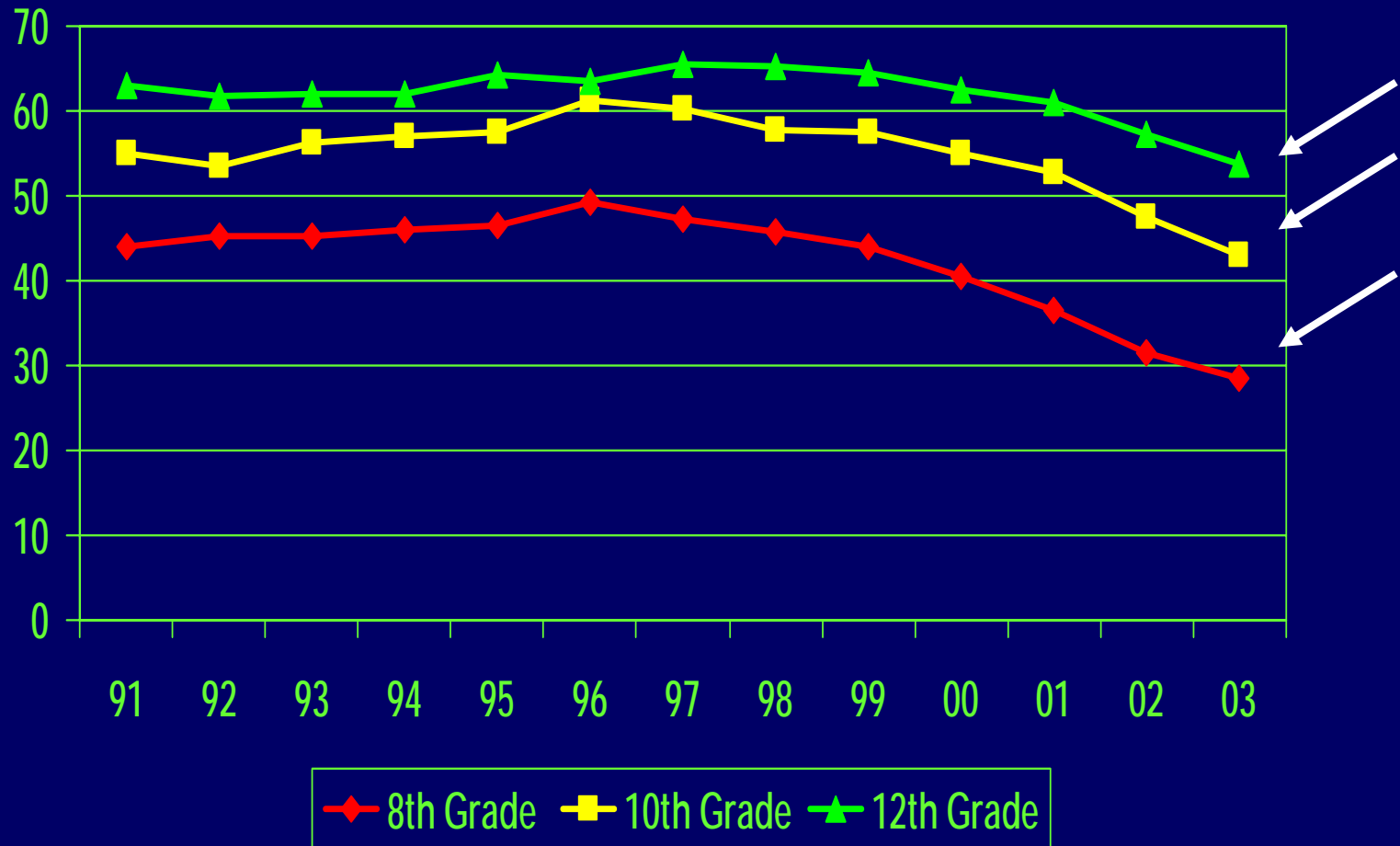
WI BSAS and DPI, 2000

WI Adolescent Binge Drinking by Gender Past Month

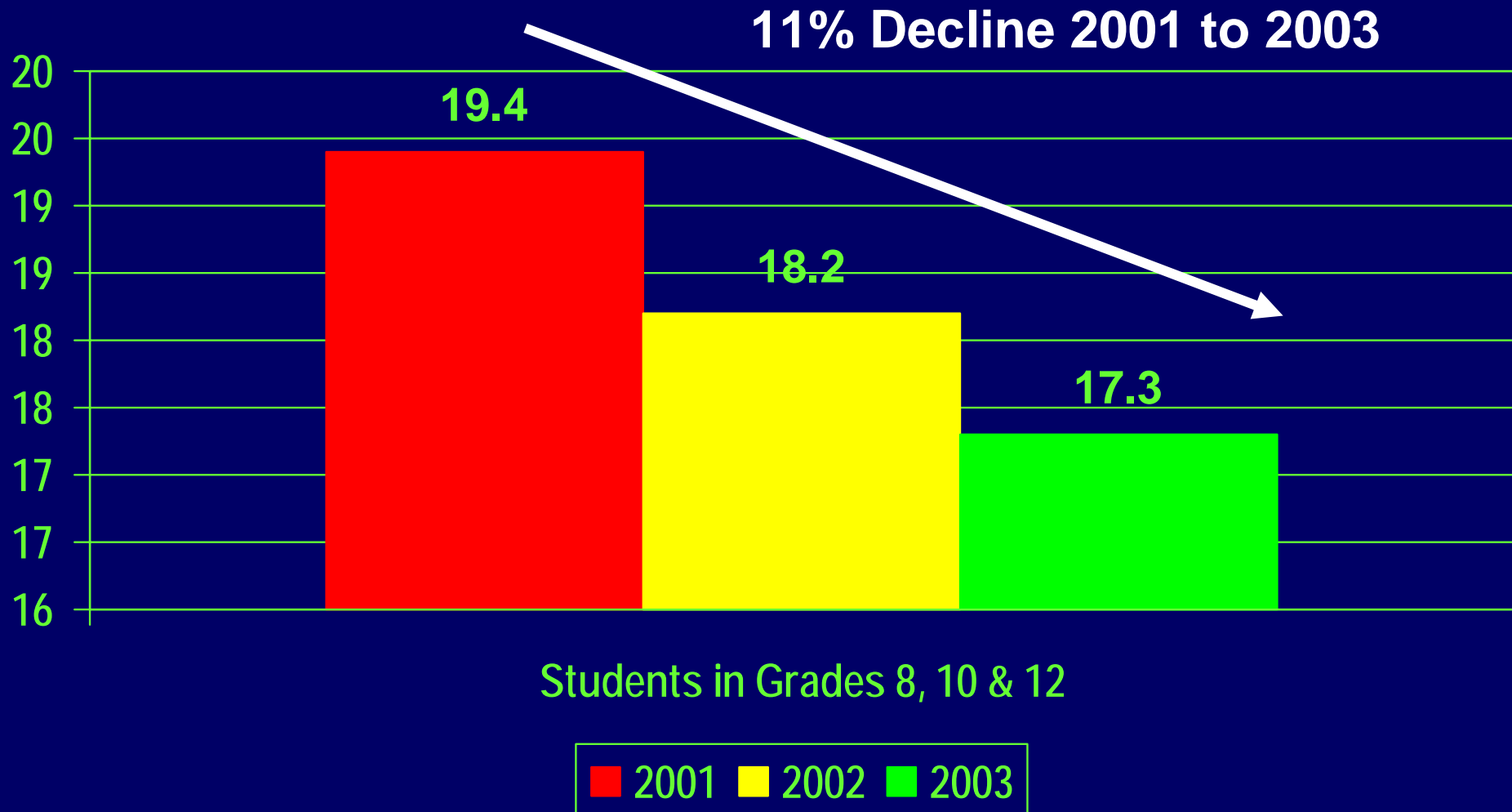


** Differences are statistically significant (with 95% confidence)*

Percent of Students Reporting Smoking Cigarettes in Lifetime, by Grade



Percent of Students Reporting *Past Month Use* of Any Illicit Drug

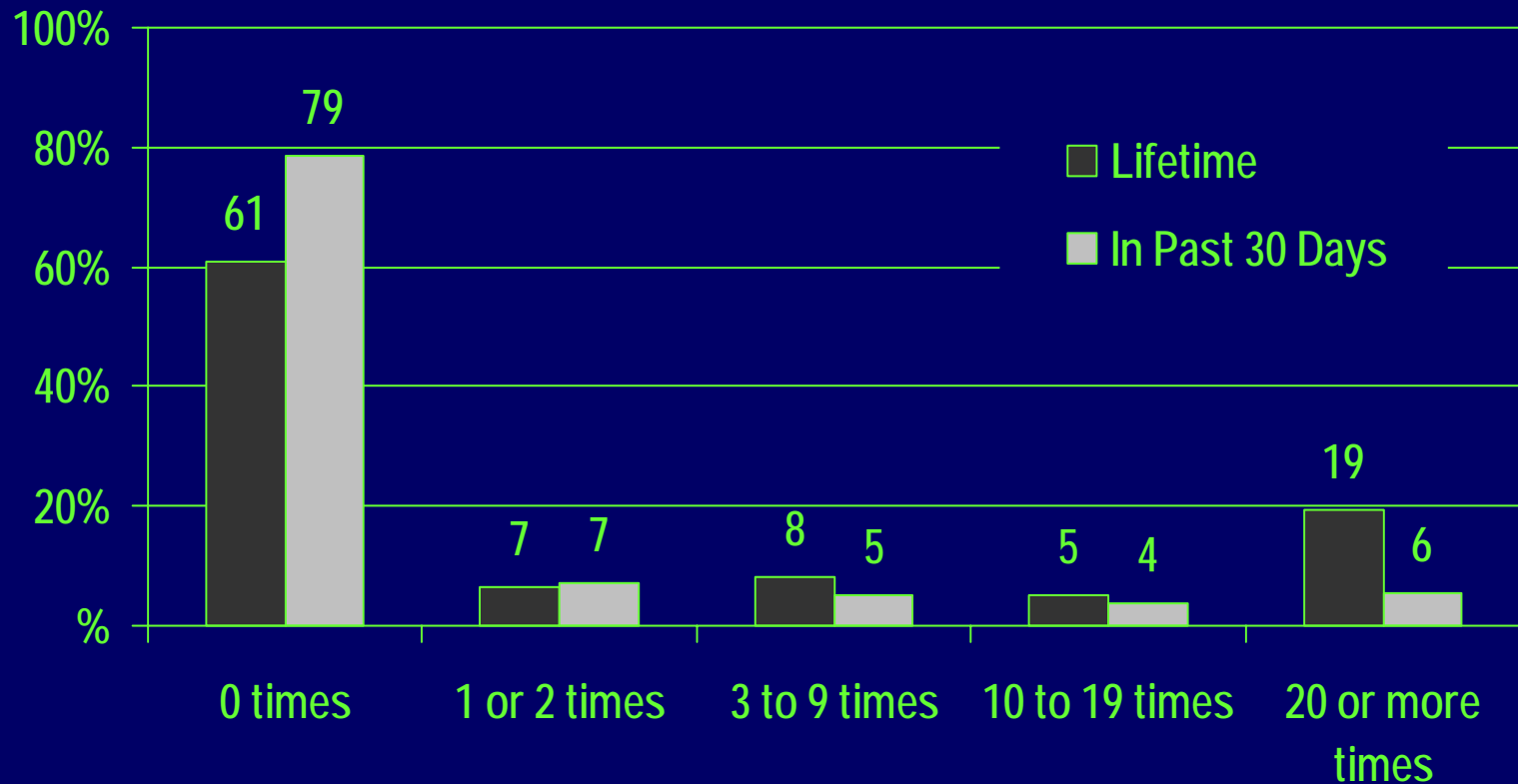


Marijuana Use Among WI Adolescents

- ◆ 22% of all students reported using marijuana in the past 30 days
- ◆ Students in Wisconsin are less likely to have ever used marijuana than the national average (39% compared to 47%)*
- ◆ Students in 1999 were significantly more likely to have used marijuana in the past thirty days than students in 1993 (22% compared to 11%)*

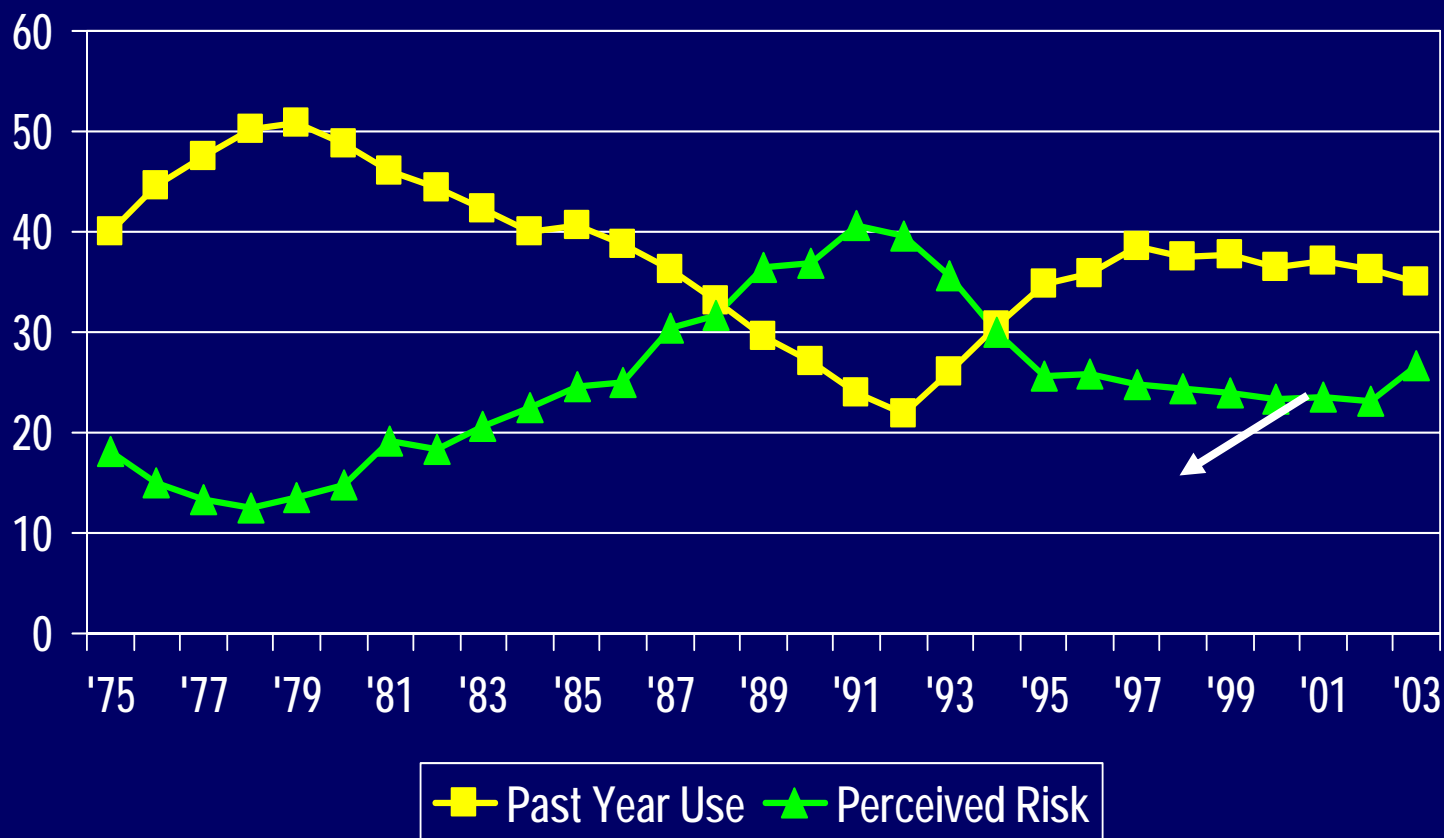
** Differences are statistically significant (with 95% confidence)*

Lifetime and Current Marijuana Use Among WI Adolescents



WI BSAS and DPI, 2000

12th Graders' Past Year Marijuana Use vs. Perceived Risk of Occasional Marijuana Use



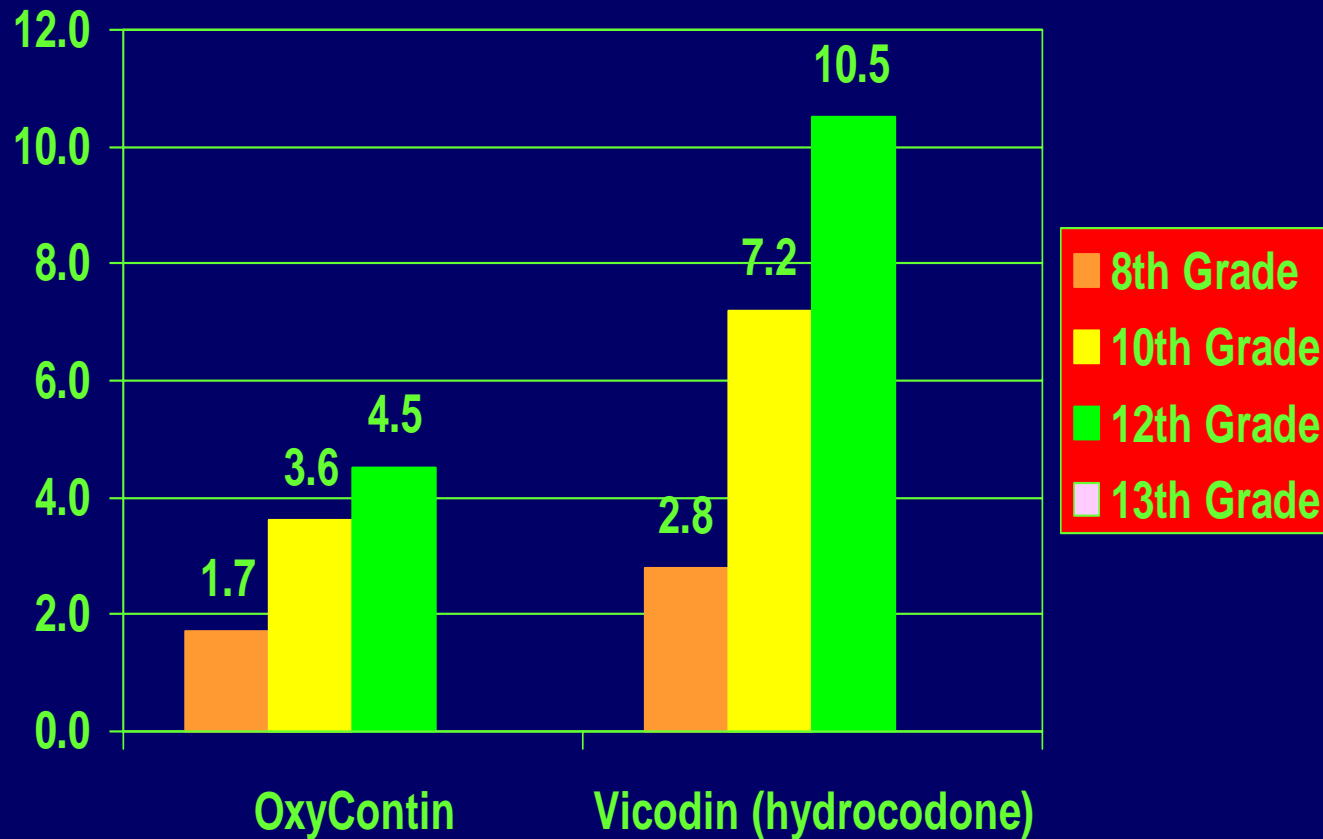
Source: National Household Survey, 2004

Cocaine and Other Drugs Among WI Adolescents

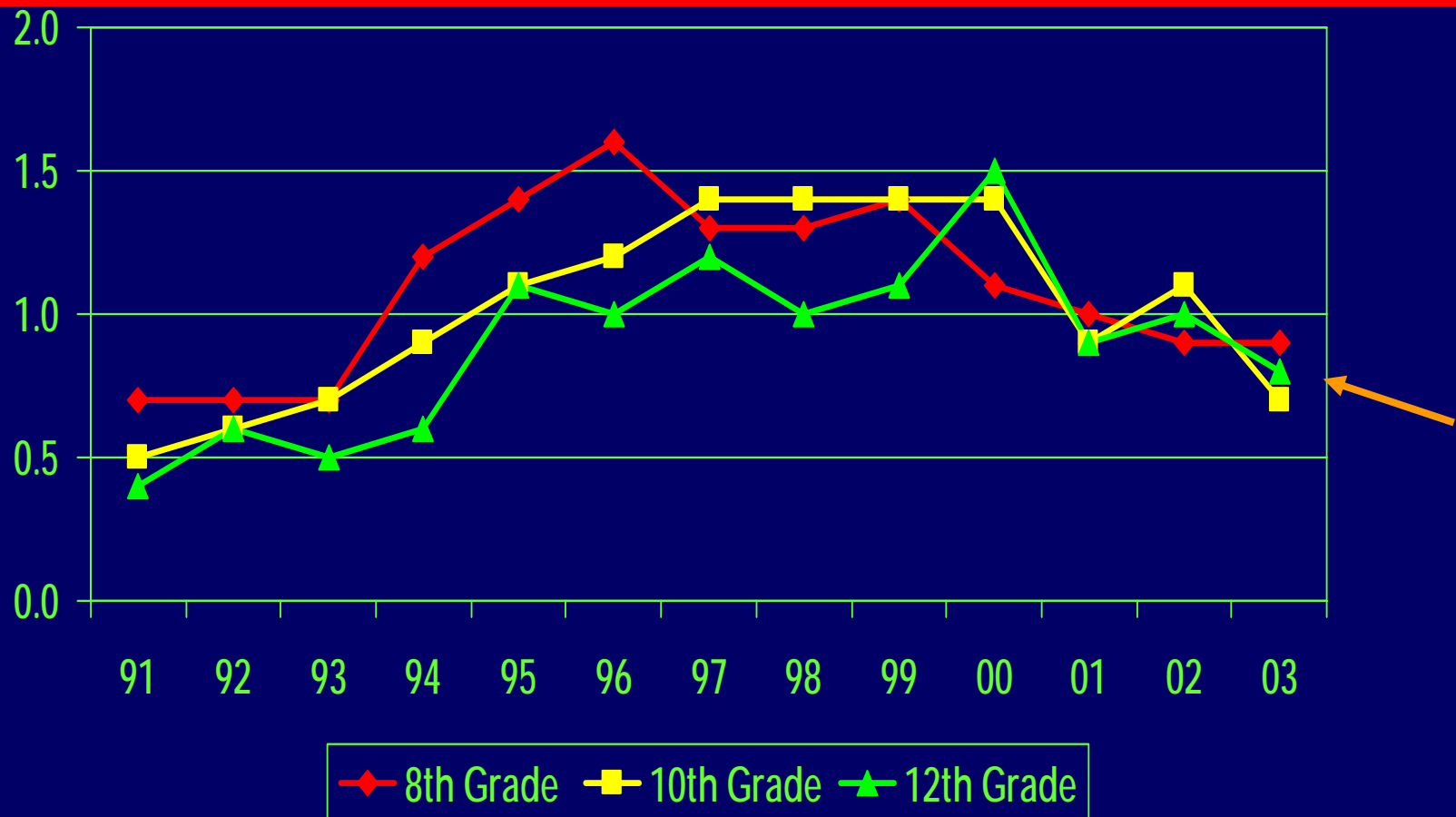
- ◆ Students in 1999 were significantly more likely to have reported using cocaine ever in their lives than students in 1993 (9% compared to 5%)*
- ◆ Students in Wisconsin are less likely to report ever using LSD than the national average (11% compared to 17%)*
- ◆ 16% used an inhalant to get high at least once in their life
- ◆ About three in ten said that someone offered, sold, or gave them illegal drugs on school property in the past 12 months

* Differences are statistically significant (with 95% confidence)

Percent of Students Reporting Nonmedical Use of OxyContin and Vicodin in Past 12 Months in 2003

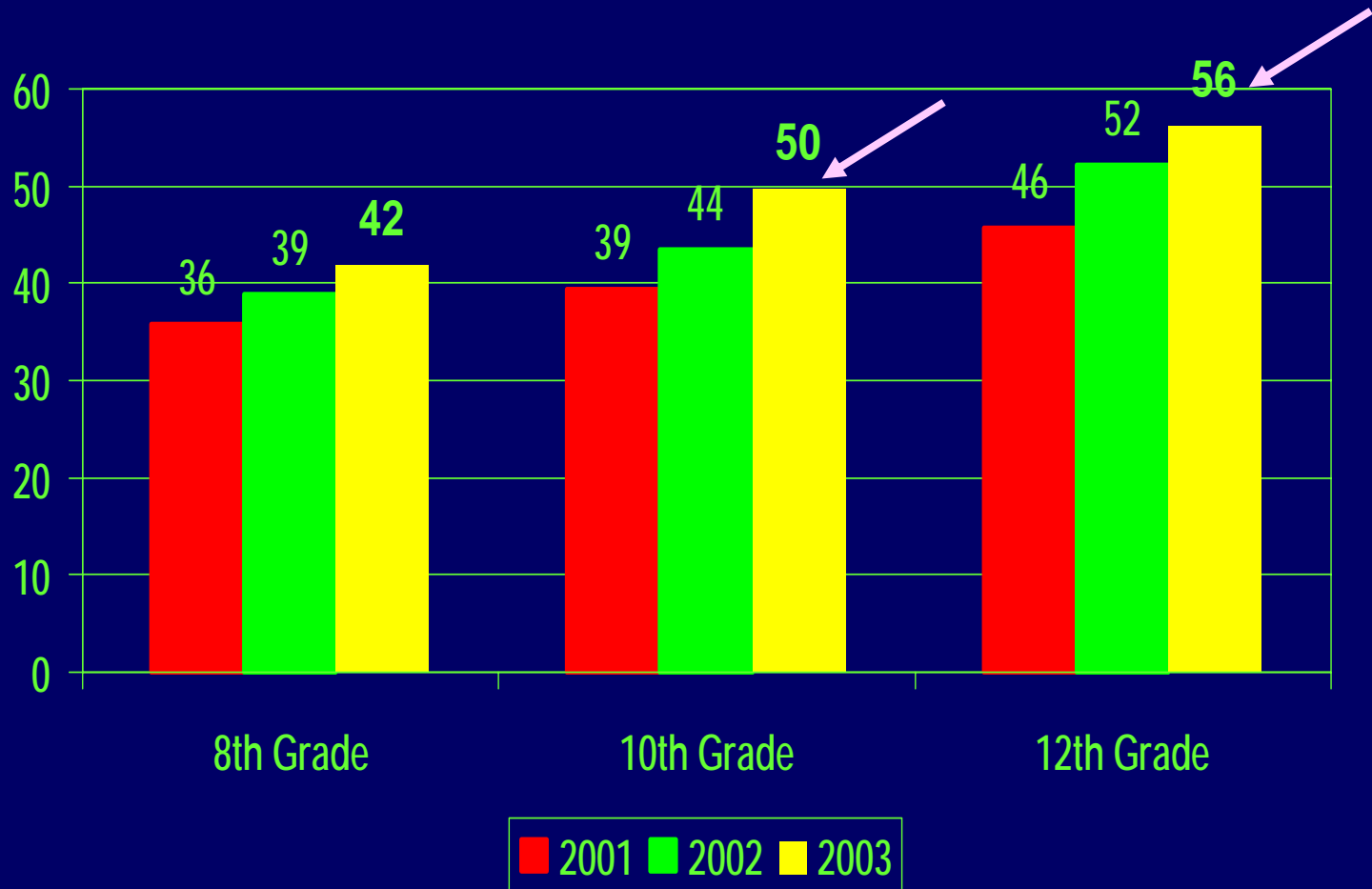


Percent of Students Reporting Use of Heroin in Past Year, by Grade

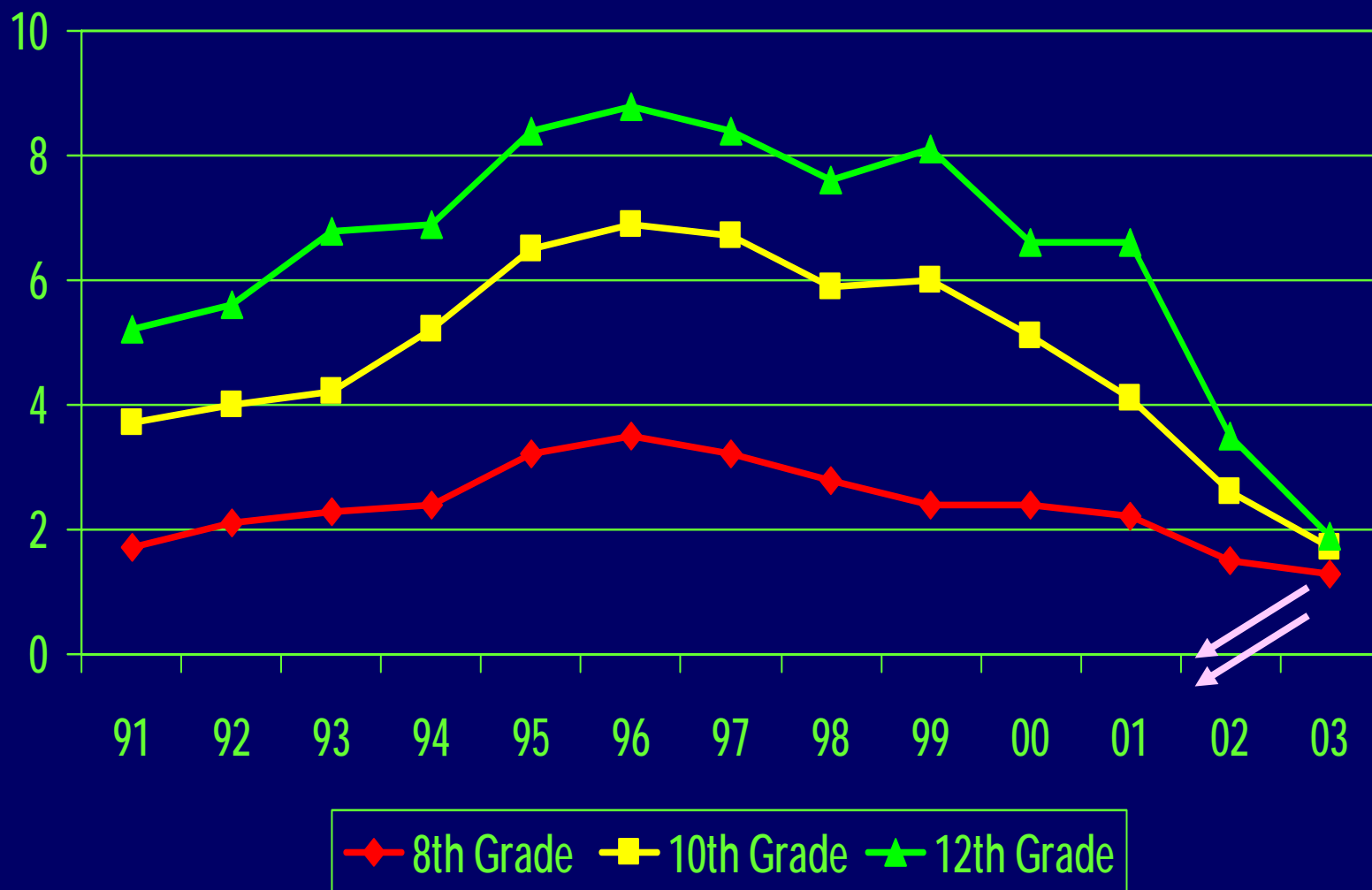


Differences from 2001 to 2002 are not statistically significant.

Perceived Risk of Trying MDMA (Ecstasy) Once or Twice, by Grade



Percent of Students Reporting Use of LSD in Past Year, by Grade



HIV Natural History

HIV exposure ↑ **Initial infection** ↑ **Viral establishment**

Agent (certain HIV strains)

Host (sex behaviors, nutrition, IVDU)

Environment (available Tx, stress, food, HIV & other pathogen prevalence)

Viral replication

Pre-AIDS (ARC)

(low CD4+, fatigue, mild malabsorption)

AIDS

(v. low CD4+, recurrent infection, cancers, CNS Disease, wasting)

Substance Use Disorders Natural History

**Initiation → Regular Consumption → Increased
(Hazardous) Use**



Non-recurrent or Rare Problems



Abuse

social problems, physical danger



Dependence

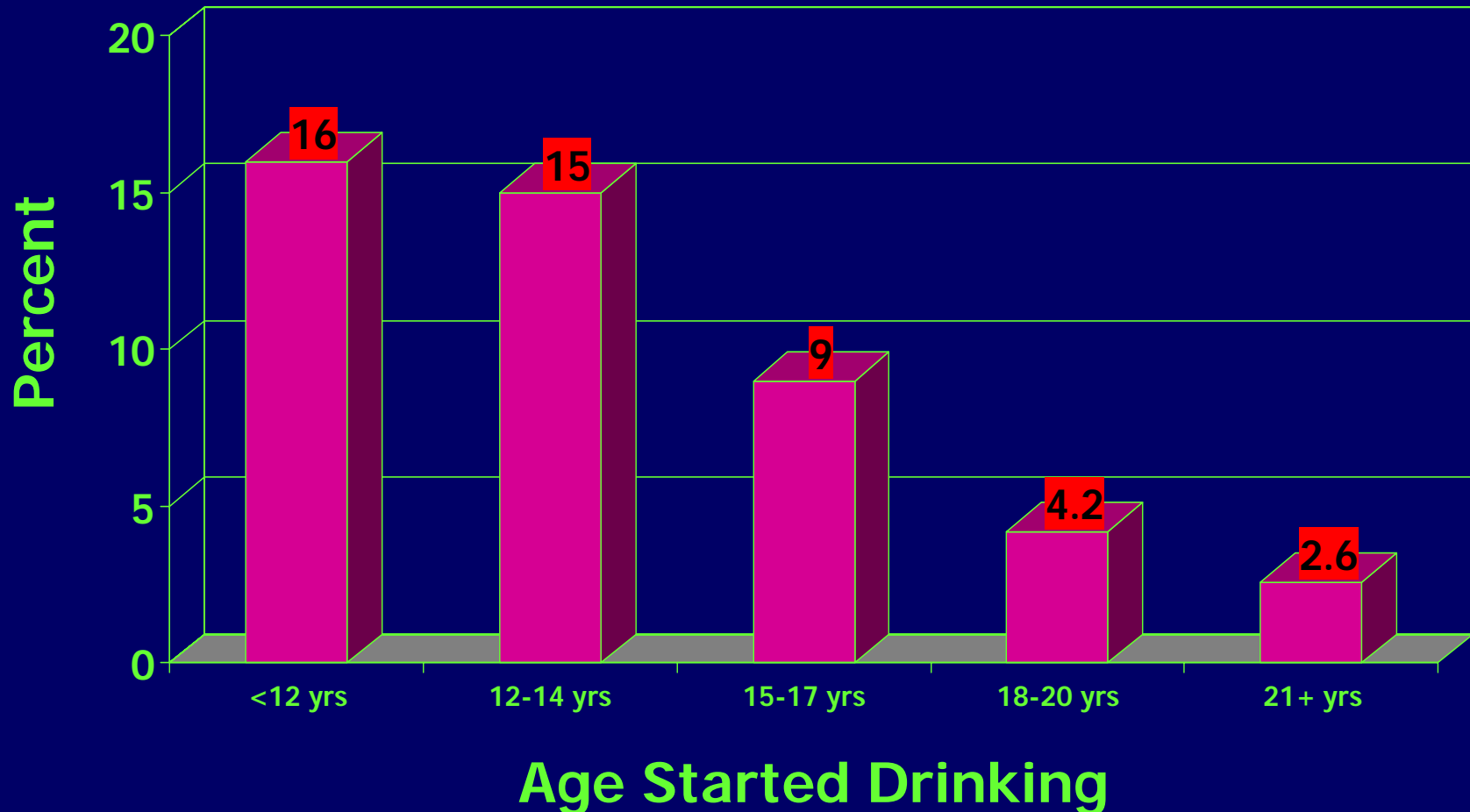
(tolerance, loss control, relapses, salience,
temporal preoccupation, use despite physical/psych harm)

Agent (certain drugs, EtOH)
Host (genes, psych disorders)
Environment (availability & price,
stress, peers, cues)

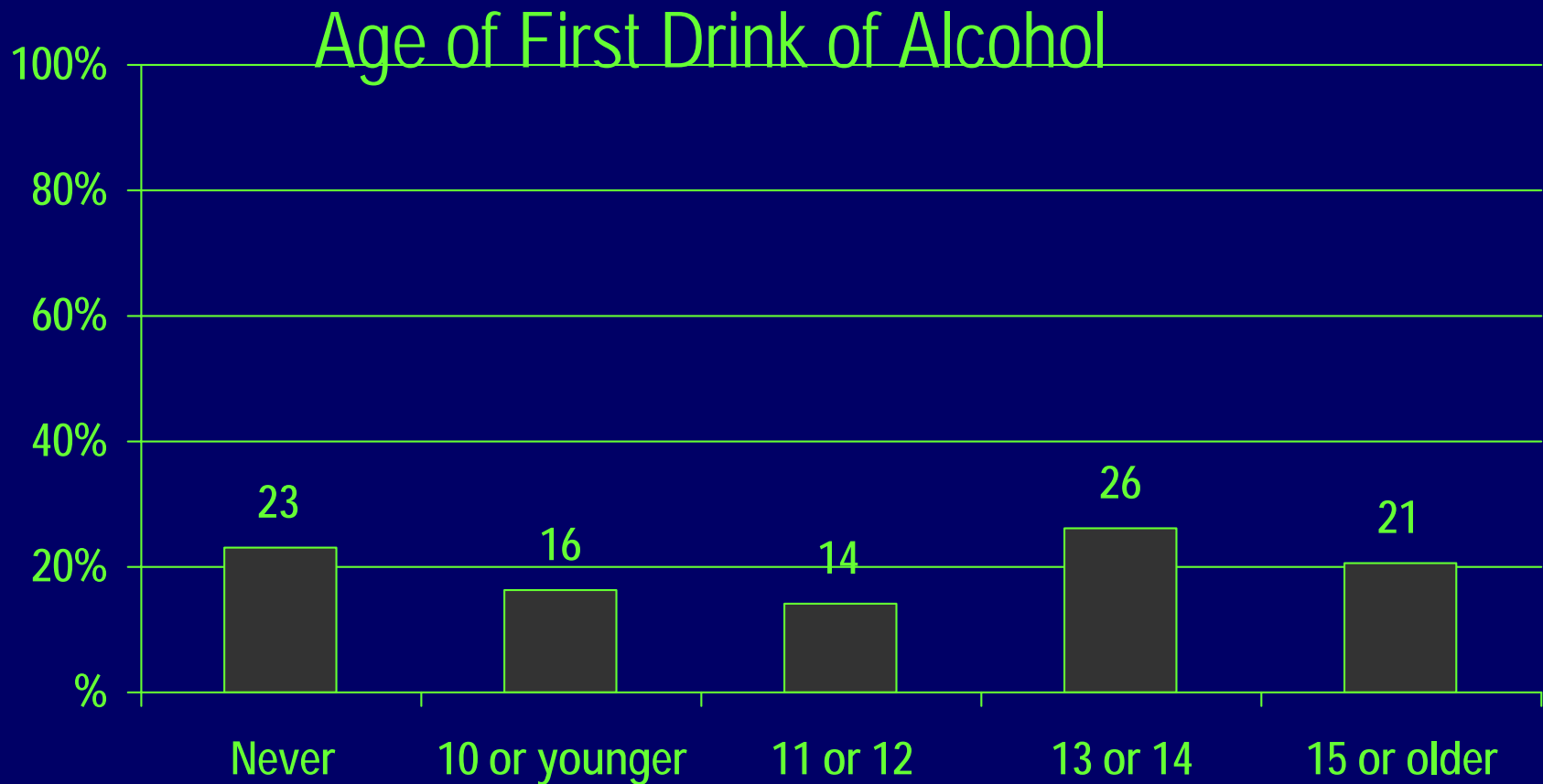
Initiation of Substance Use

- **AGENT:** drugs, price, access/availability
 - **Low price:** inhalants < cigarettes < MJ, EtOH
 - **Availability:** inhalants, cigarettes > MJ > EtOH
 - **Price effects on tobacco, EtOH**
- **HOST:** O.D.D., Conduct, anxiety & affective disorders, beliefs, success (problem solving, school)
 - **ADHD risk only if O.D.D.+ /or conduct coexist**
- **ENVIRONMENT:** family & personal beliefs, parental monitoring
 - **Greatest contribution to risk is peer use**

Percentages of Past Year Alcohol Dependence or Abuse Among Adults Aged 21 or Older, by Age of First Use (SAMHSA, 2004)

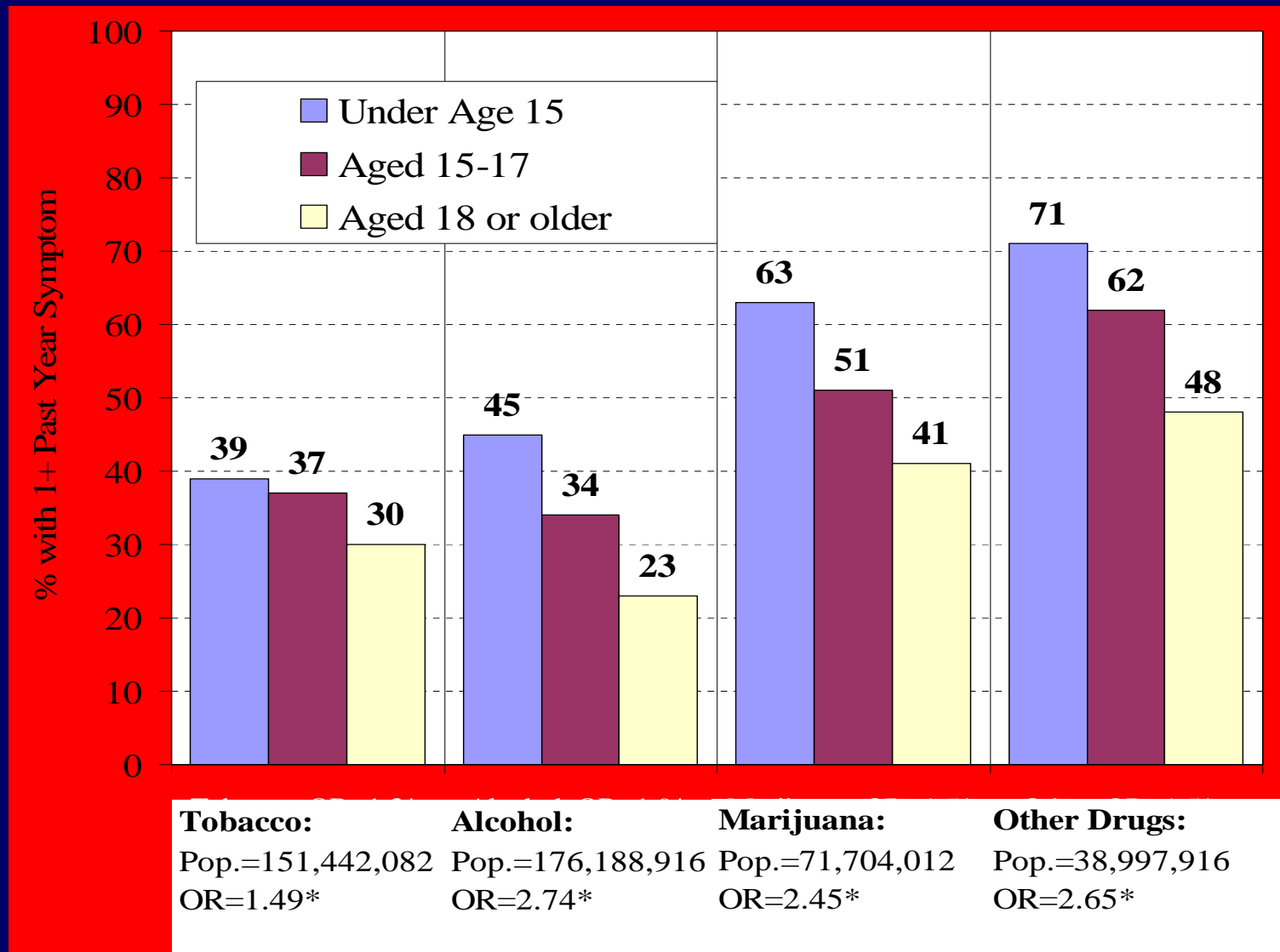


WI Adolescents: Onset of Drinking



WI BSAS and DPI, 2000

Age of First Use Predicts Dependence an Average of 22 years Later

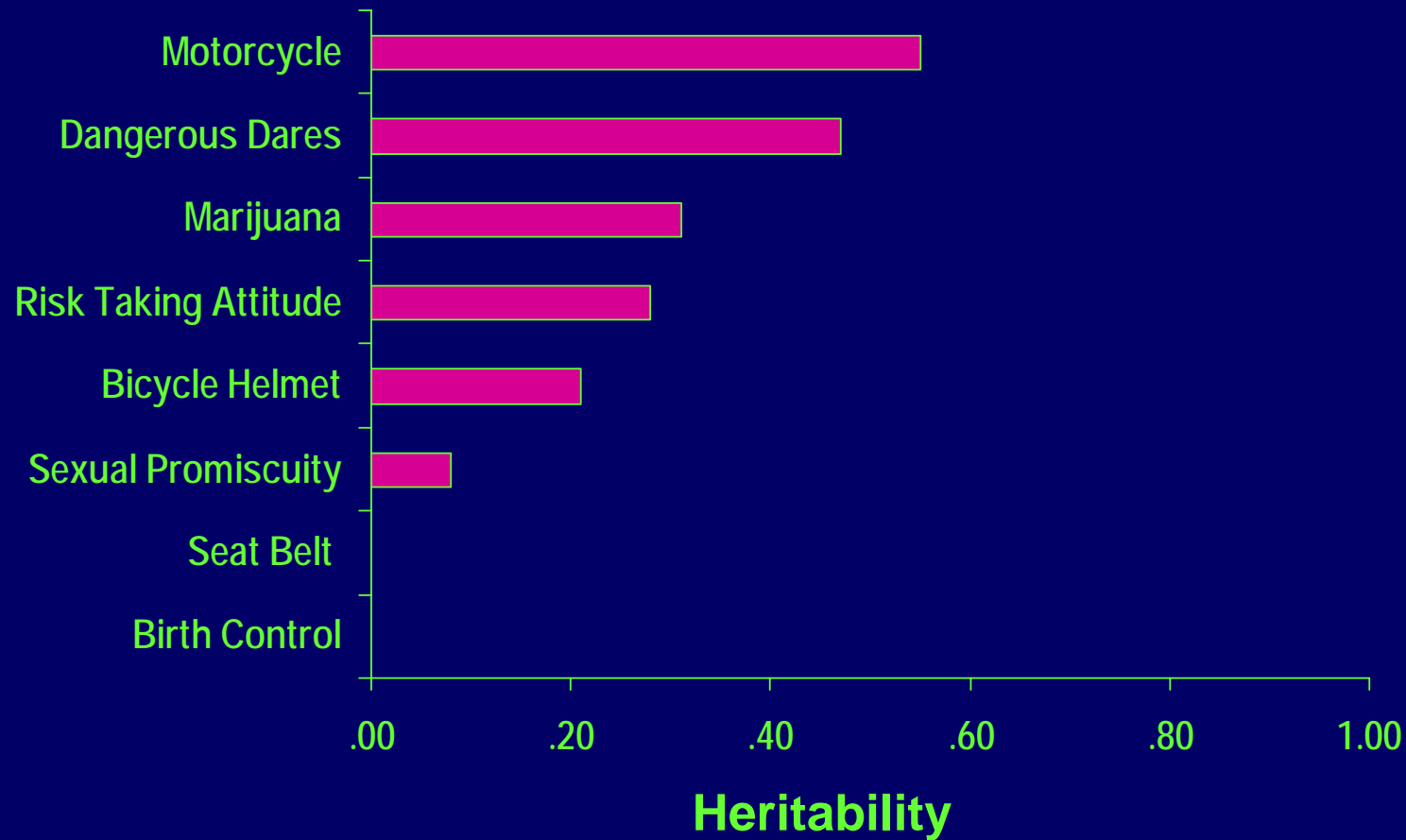


Source: Dennis, Babor, Roebuck & Donaldson (2002) and 1998 NHSDA

Risks for Abuse and Dependence

- **PERSONALITY TRAITS [SENSATION SEEKING, SHYNESS/DEPRESSION] HERITABLE RISKS**
- **AGE 3 BEHAVIOR: 2 PATHS-HYPER & SHY**
- **LOW ALCOHOL REACTIVITY --> 3- 4 X RISK**

Heritability of Risk Taking Behaviors in 738 Twin Pairs

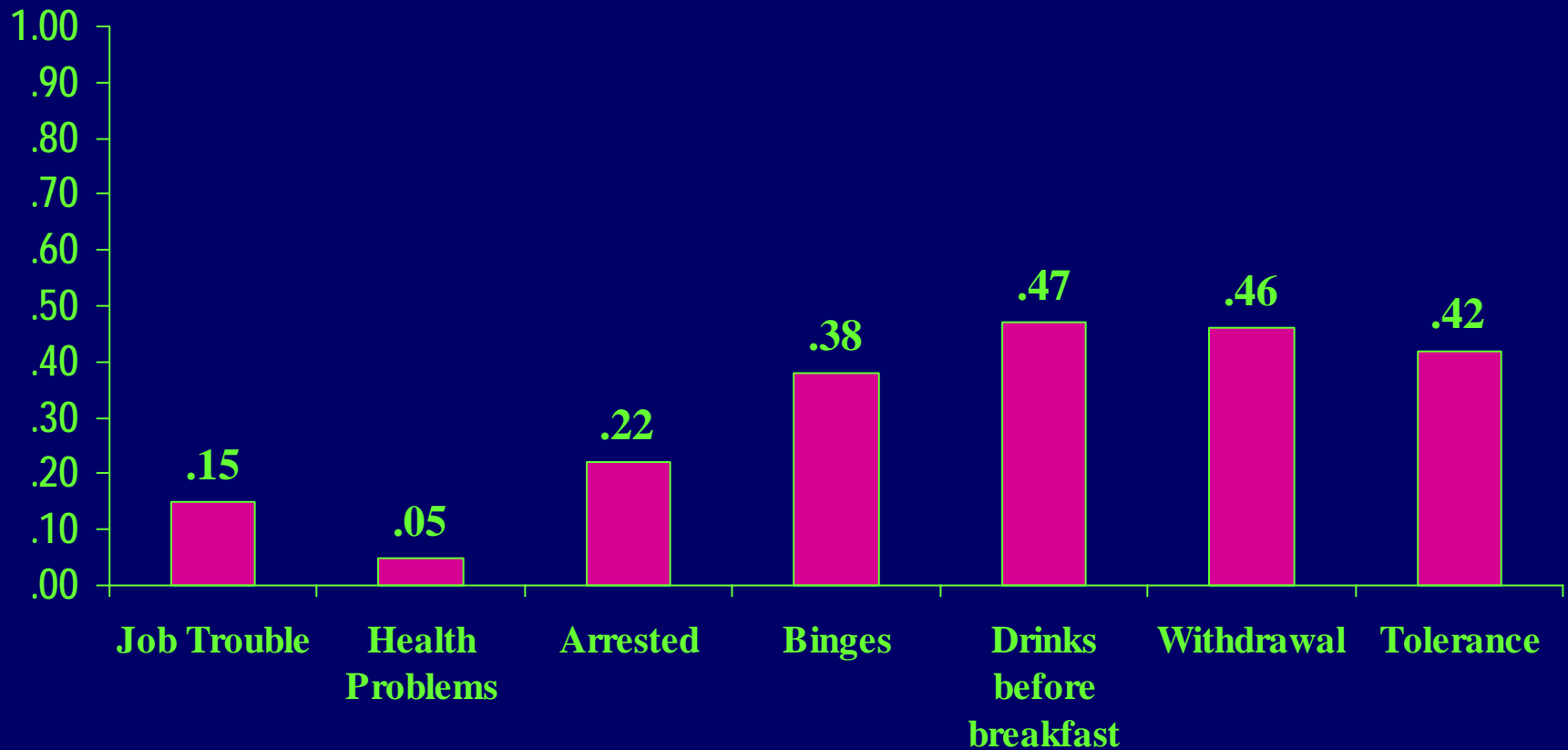


Miles et al., 2001

GENETICS OF HUMAN ALCOHOLISM

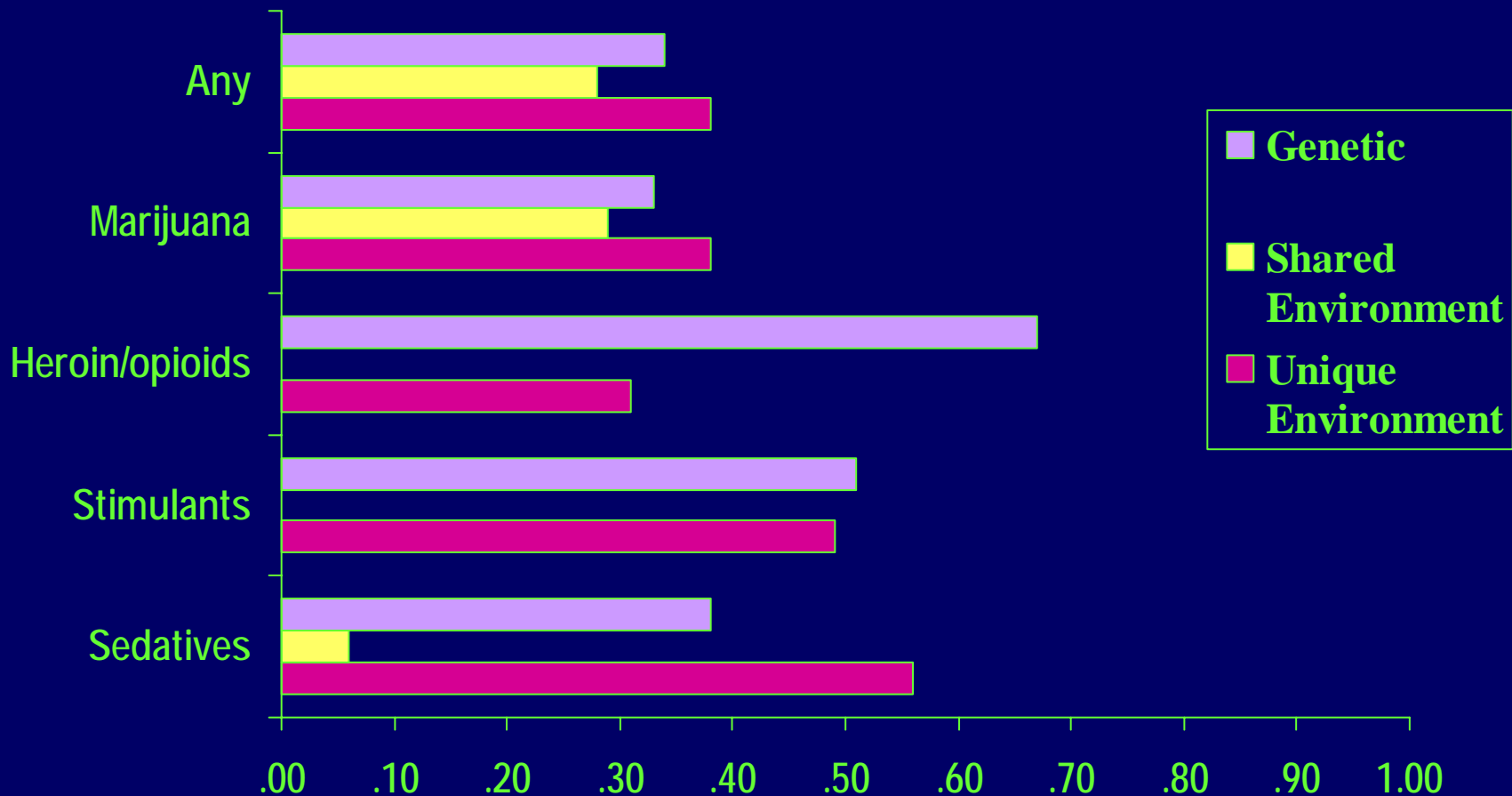
- ALCOHOLISM RUNS IN FAMILIES:
 - 4X-INCREASED IF 1 PARENT ALCOHOLIC
- IDENTICAL > FRATERNAL TWINS
- ADOPTION: no FH effect in early onset cases
- ALCOHOLISM VERY HERITABLE: 40-65%
 - ≥ type II diabetes, early MI, asthma
- 7 RISK Regions on 6 chromosomes
- 2 PROTECTIVE GENES: adh, aldh2

Heritability of Specific Alcohol Problems



Slutske et al., 1999

Contributions* to Illicit Drug Dependence



*Proportions of Variance

Tsuang et al., 2001

Vulnerability of brain in adolescence

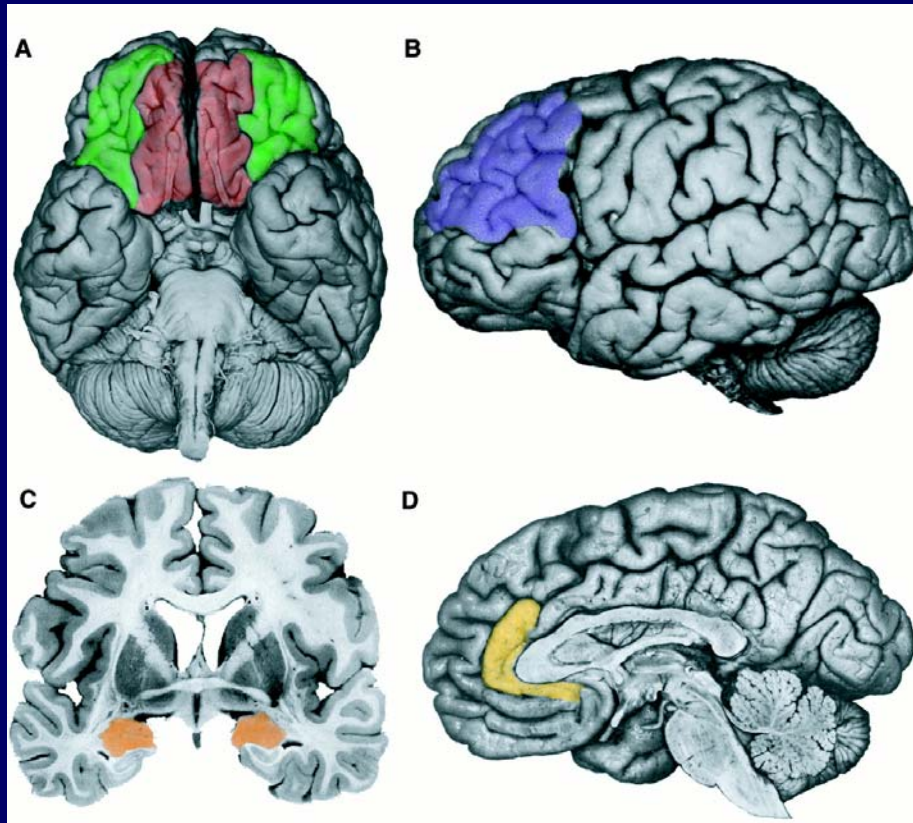
- ◆ normal adolescent brain development
- ◆ relationship to development of addiction
- ◆ relationship to other risk taking behavior

Most important developmental tasks in adolescence

- ◆ Establish autonomy: be my own boss
- ◆ Belong to a group of peers
- ◆ Be good at something
- ◆ Be aware of and express emotions

EMOTION-RELATED BRAIN STRUCTURES

**ORBITO
FRONTAL
CORTEX**



**DORSO-
LATERAL
PRE-
FRONTAL
CORTEX**
Consider
options

**ANTERIOR
CINGULATE**
Attend
Interest

AMYGDALA
Angry fear, sad

THE BRAIN IS MY SECOND FAVORITE ORGAN

--Woody Allen

Orbitofrontal Prefrontal Cortex:

Adult Functions

- **Learning new or modified motor behaviors after a new or related cues**
- **Inhibiting dominant behavior after new cues**
- **Inhibiting amygdala and stress response**
- **Reducing consumptive behavior after satiety**

- Adolescent brain develops in major ways from ages 11-24
- Large # connections undergo pruning (ages 11 F, 12.5 M)
- Increased myelin sheathing helps neurons carry signals more quickly and efficiently
- Net effect: more specific, faster connections.

INSIDE THE ADOLESCENT BRAIN

The brain undergoes two major developmental spurts, one in the womb and the second from childhood through the teen years, when the organ matures by fits and starts in a sequence that moves from the back of the brain to the front.

Nerve Proliferation ...



By age 24 for girls and 25 for boys, the neurons in the back of the brain have formed the majority of new connections. The 200,000 new synapses made at these 14 to 18 years old.

Corpus Callosum

Thought is an intricate and intricate process. In the brain, this bundle of nerve fibers connects the left and right hemispheres of the brain. It's the bridge that allows the two sides to work together and process information.

Prefrontal Cortex

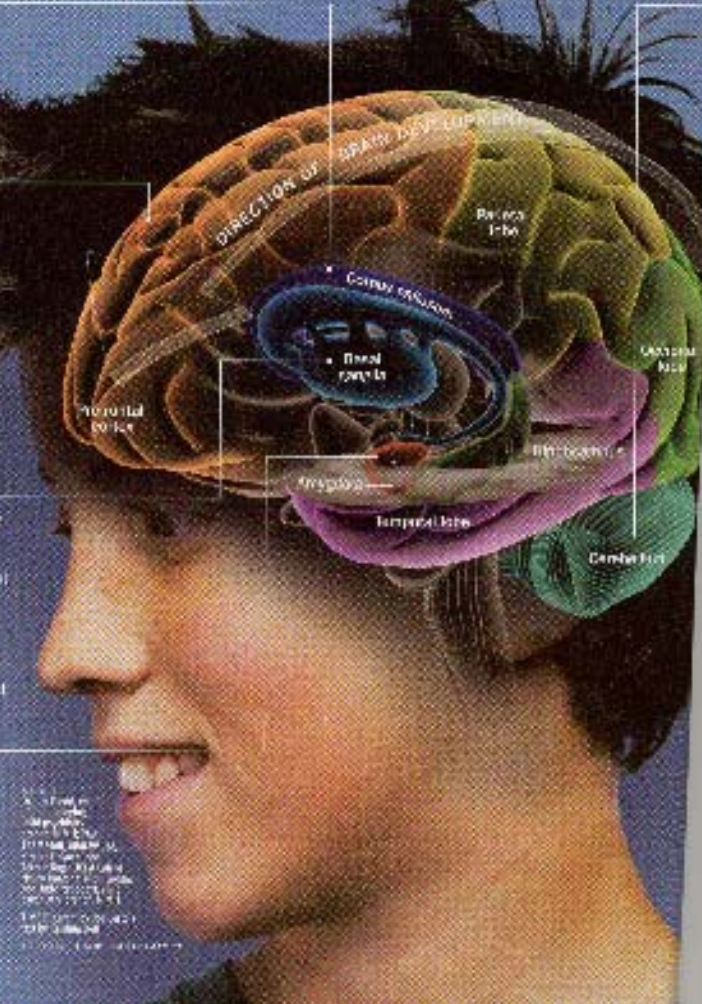
The CEO of the brain, the prefrontal cortex is the last part of the brain to mature. It's the part of the brain that controls the body's movements, the part that controls the body's movements, the part that controls the body's movements.

Basal Ganglia

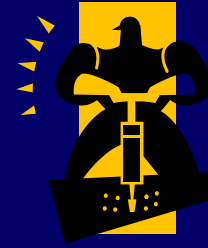
Located in the brain, the basal ganglia are a group of structures that help control the body's movements. They are the part of the brain that controls the body's movements, the part that controls the body's movements.

Amygdala

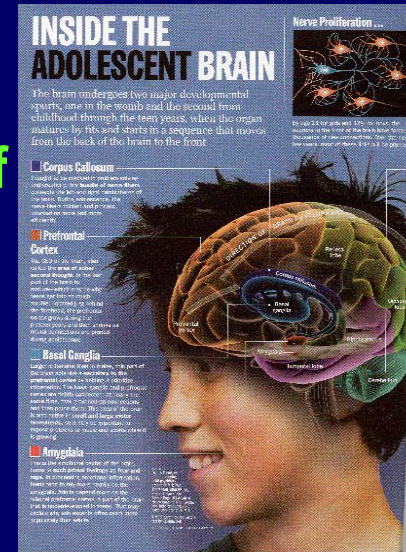
The amygdala is a small, almond-shaped structure in the brain that is involved in processing emotions. It's the part of the brain that controls the body's movements, the part that controls the body's movements.



Arrested Development



- **Synapse pruning & myelination begins in back of brain & ends in prefrontal cortex**
 - **sensory & physical activities preferred, esp. if effortless & exciting**
 - **propensity toward risky, impulsive behaviors**
 - **group setting may promote risk taking**
 - **poor planning and judgment**
 - **poor modulation of angry, sad, and fearful emotions**
 - **heightened interest in novel stimuli**

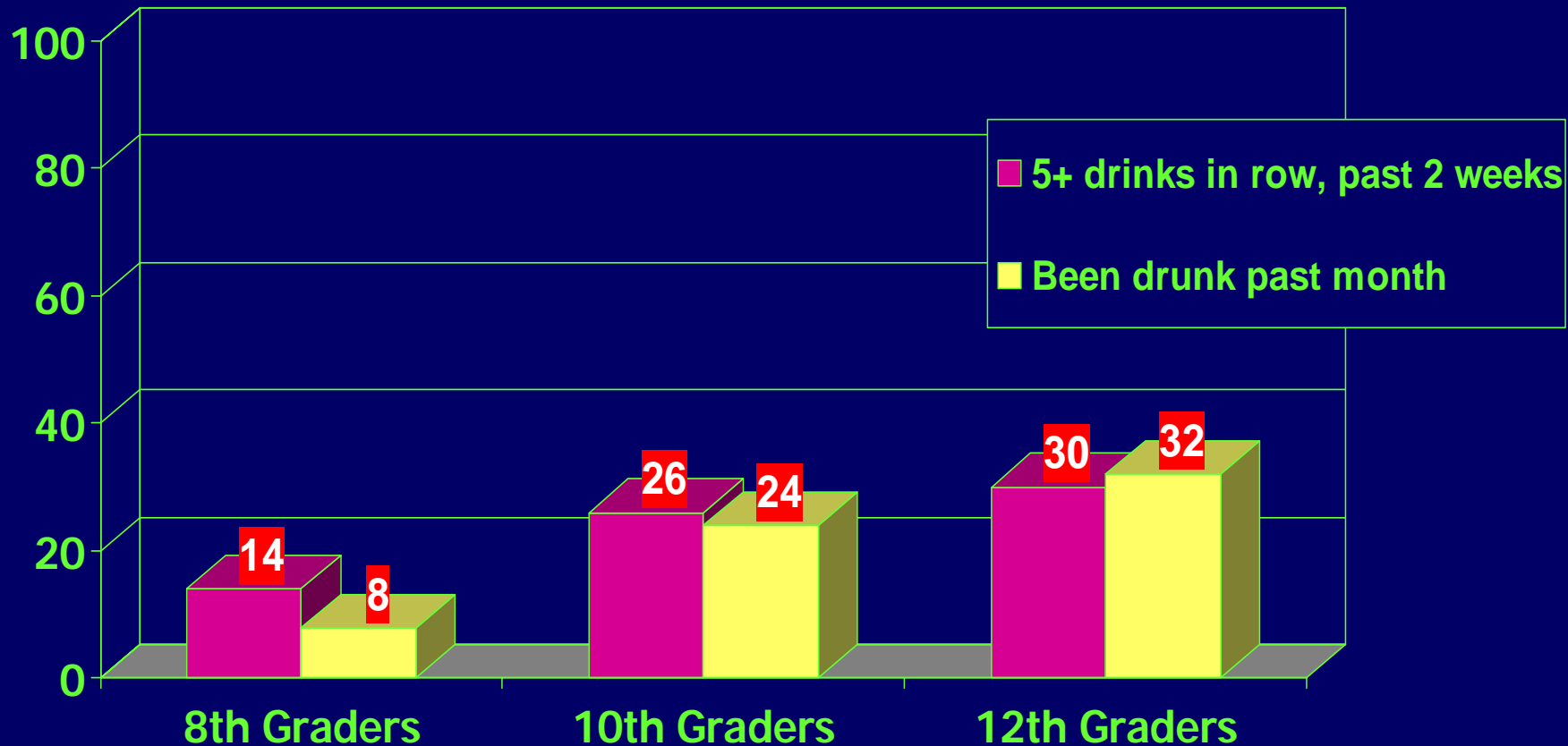


Important brain development in adolescence

- ◆ Pruning and myelination of PFC-AMG tract → enables emotional stability
- ◆ Myelination of OFC-DLPFC-NAcc tract → think of choices and planning

Survey Data Suggest that Adolescents Feel Less Sensitive to Alcohol's Effects

Monitoring the Future, 2001



Are adolescents more susceptible to alcohol than adults?

Adolescent rats are more sensitive to the social disinhibition induced by alcohol use



Are adolescents more susceptible to alcohol than adults?

Adolescent drunk rats perform worse on memory tasks than adult drunk rats

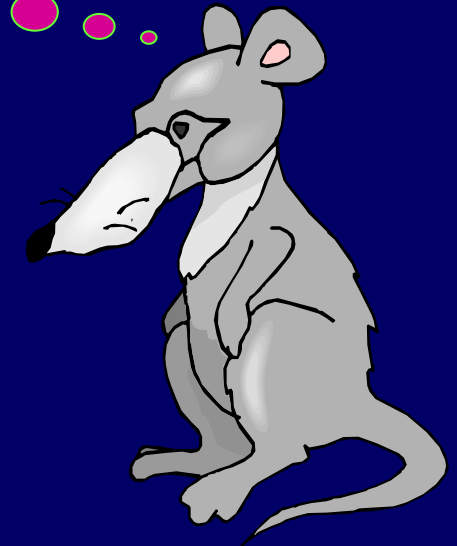
converts
information
to memory

Huh?

disrupts the hippocampus

brain damage in the PFC

planned
thinking



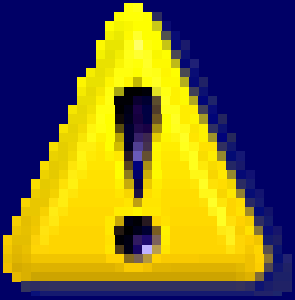
Alcohol's Effects on Adolescent Brain

- **Adolescents with a history of extensive alcohol use, compared to a control group....**

Reduced hippocampus volume (10-35%)

Less brain activity during memory tasks

Brown, 2002; Wuethrich, 2001



- **Normal adolescent brain development likely contributes to....**
 - > risk taking (particularly in groups)
 - > reinforces low effort - high excitement activities
 - > interest in novel stimuli
 - < good judgment & weighing consequences

Concepts of reinforcement & reward

In general people use drugs because they are rewarding, making the person:

- ◆ Feel good (sensation-seeking)
- ◆ Feel better (self-medication)

Definition: if an organism continues to do work to get something, even if there is no evidence it is rewarding, the drug is *reinforcing the work (behavior)*!

What might be reinforced by drug effects?

- ◆ Alcohol +/- drug seeking behavior
- ◆ Alcohol +/- drug taking behavior
- ◆ Drug culture (people, places, things)

Brain Reinforcement System

- **DOPAMINE** TRANSMITTER CHEMICAL
- APPROACH SYSTEM; SETS PRIORITIES
- VENTRAL TEGMENTAL AREA [VTA]
- NUCLEUS ACCUMBENS [NAcc]
- CONNECTED TO BRAIN AREAS FOR
 - PLANNING** [PFC, ACC]
 - EMOTION** [AMYGDALA, ACC]
 - MEMORY** [HIPPOCAMPUS]

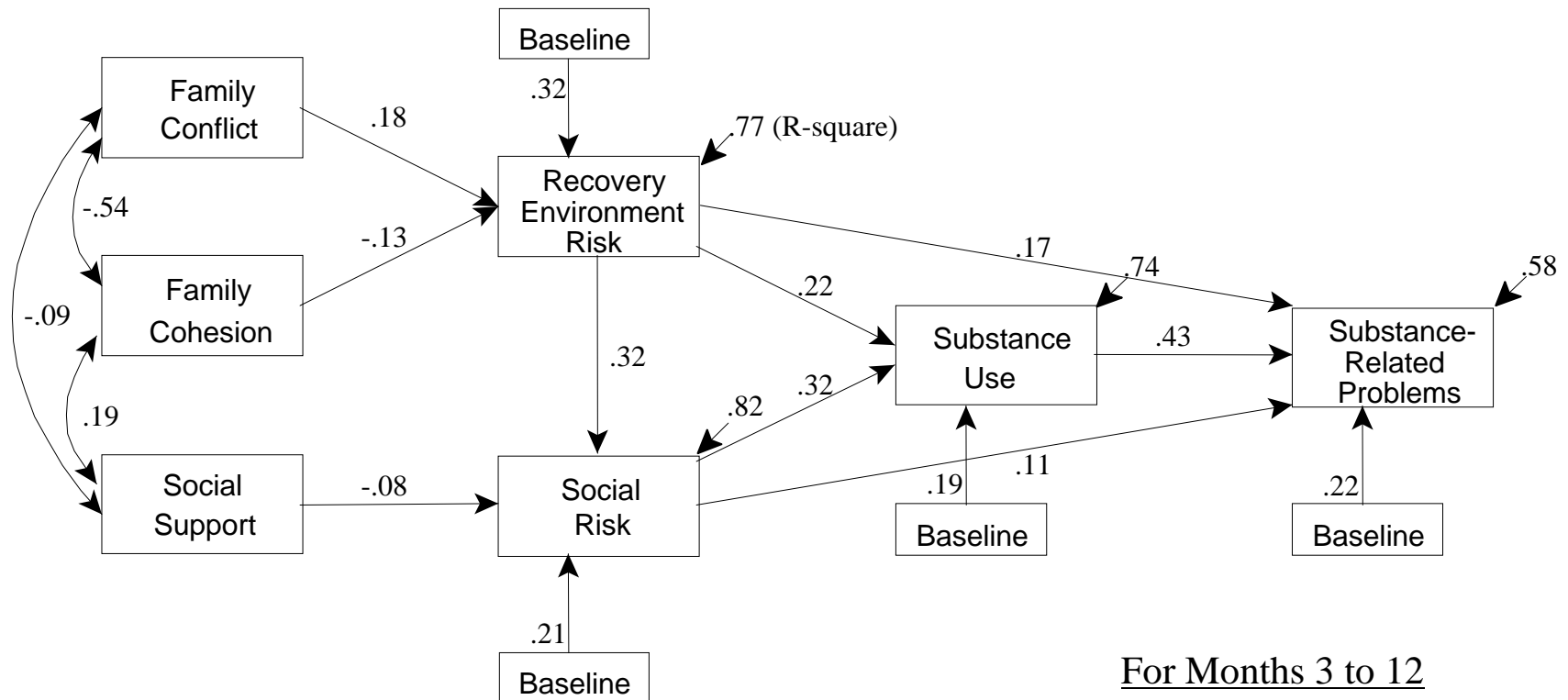
Addictive Substances Markedly Increase Dopamine (DA) Release

<u>Reward</u>	<u>Peak DA Release</u>
PALATABLE FOOD:	50%↑
SEX	50-100%↑
ETHYL ALCOHOL	125-200% ↑
CANNABIS [THC]	125-175% ↑
NICOTINE	225%↑
MORPHINE/HEROIN	150-300% ↑
COCAINE	400% ↑
AMPHETAMINE	1000% ↑

Why stopping use permanently is unlikely in adolescence

- ◆ Changing peers not easy to reinforce
- ◆ Poor impulse control, esp. if ADHD, Bipolar I or II, ODD, or CD
- ◆ Poor affect regulation esp if above or depression or anxiety disorder
- ◆ Ongoing family conflict/ lack of cohesion may increase relapses

Environmental Factors were the Main Predictor of Relapse/Continued Use




For Months 3 to 12
CFI=.97 to .99,
RMSEA=.04 to .06

How to support autonomy & stop adolescent substance use?

- ◆ **Punish the user:** nag, plead, lecture, yell
- ◆ **Remove reinforcers:** no car, no cash, no friends, ground (for life?)
- ◆ **Reinforce other behavior:** contingent rewards follow unambiguous healthy activity

Effectiveness was also associated with therapies that technologically were:



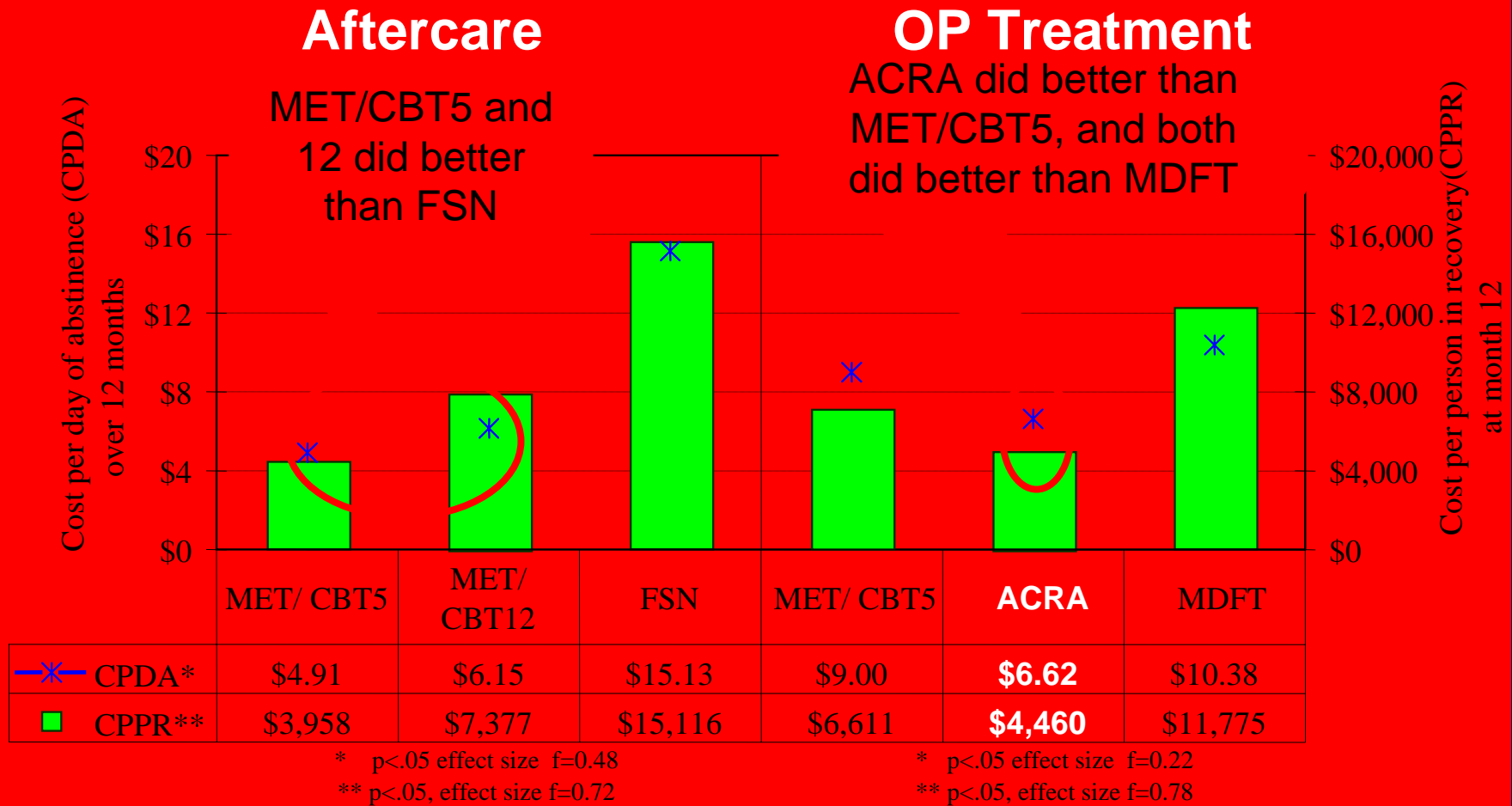
- ◆ manual-guided
- ◆ had developmentally appropriate materials
- ◆ involved more quality assurance and clinical supervision
- ◆ achieved therapeutic alliance and early positive outcomes
- ◆ successfully engaged adolescents in aftercare, support groups, positive peer reference groups, more supportive recovery environments

Effective Adolescent Substance Interventions: Controlled Clinical Trials



TREATMENT MODALITIES	<i>N</i>	EFFECT
Behavioral therapies (ACRA)	5	+++
MET	4	++
Relapse prevention	3	++
Structured family therapy	7	+ / ++
Twelve step treatments	1	+

Cost-Effectiveness in CYT Study



12 wks OF MET, CBT (5/12 sessions, MDFT (Multidimensional Family Treatment), FSN (Family Support Net), or ACRA (Adolescent Community Reinforcement Approach)

Source: Dennis et al., 2004

Adolescent Community Reinforcement Approach

- ◆ Evaluate reinforcers for substance use and for non substance using behaviors
- ◆ Set positive expectations that client will meet his/her goals & emphasize evidence of efficacy of CRA
- ◆ Time limited: Not for rest of your life
- ◆ Emphasize independence and building reinforcers for non using behavior: not what you give up, but what you gain elsewhere
- ◆ Teach skills in vivo
- ◆ Emphasize building self efficacy

Examples of Behaviors to Change

- ◆ School attendance and promptness
- ◆ Promptness of return from night out
- ◆ Abstinence from Alcohol/Abusable drug use
- ◆ Obtaining, attending and being paid for job
- ◆ Taking Rx
- ◆ Regular exercise
- ◆ Spend time with siblings, parent
- ◆ Make new acquaintances or socialize

Include other important ACRA elements

- social club

- job club

- contingency management

- addiction Rx

 - e.g., Suboxone for opiate dependence

- family training

OBJECTIVES-Summary

- Alcohol and drug use common and early in onset
- Delayed maturation of prefrontal cortex leads to increased affective lability & impulsivity
- Reward pathway and critical structures that explain adolescent onset
- Significant genetic component
- Reward-based treatment & psych comorbidity treatment appear critical for success
- Outcomes of abstinence unusual, but need to adopt long-term view of outcomes

REFERENCES

ADOLESCENT SUBSTANCE USE

Wisconsin Youth Risk Behavior Survey:

<http://www.dpi.state.wi.us/dpi/dlse/sspw/yrbsindx.html>

BRAIN AND ADOLESCENT BRAIN DEVELOPMENT

Dubuc, B. (2004). *The brain from top to bottom.*

www.thebrain.mcgill.ca/flash/indexd.html#

Walsh, D. *Why do they act that way? : A survival guide to the adolescent brain for you and your teen.* (2004). NY: Simon & Schuster

ADOLESCENT AODA TREATMENT MANUALS

ACRA and other CYT manuals

www.chestnut.org/li/apss/csat/protocols

<http://kap.samhsa.gov/products/manuals/cyt/index.htm>

ADOLESCENT AODA TREATMENT STUDIES

Cannabis Youth Treatment (CYT) : www.chestnut.org/li/cyt

Resources (continued)



Assessment Instruments

CSAT TIP 3 at

http://www.athealth.com/practitioner/ceduc/health_tip31k.html

NIAAA Assessment

Handbook, <http://www.niaaa.nih.gov/publications/instable.htm>

Adolescent Treatment Manuals

CSAT CYT and other manuals at

www.chestnut.org/li/apss/csat/protocols or

www.chestnut.org/li/bookstore

SAMHSA at <http://kap.samhsa.gov/products/manuals/cyt/index.htm>

Adolescent Treatment Programs and Studies

Cannabis Youth Treatment (CYT) : www.chestnut.org/li/cyt

Persistent Effects of Treatment Study of Adolescents (PETSA):

www.samhsa.gov/centers/csat/csat.html (then select PETS from program resources)

Adolescent Program Support Site (APSS): www.chestnut.org/li/apss